

REMARKS

Amendment To The Specification

In compliance with the Examiner's requirement, description pages have been amended to use proper designation of the trademark, LINCOLN LOG®.

The claims have been amended to more clearly and concisely recite the present invention. Particularly, claim 1 has been amended to combine some of the subject matter of claim 2 with claim 1. Claim 1 has also been amended to recite the growth of colloidal photonic crystals in surface relief patterns exhibiting Bragg diffraction. Support for these amendments is found in several places in the specification. Broadly speaking, that attainment of colloidal photonic crystals which exhibit this property is discussed in the Field of Invention on page 1, lines 16 to 18, and more particularly in the Summary of Invention, on page 18, lines 1 to 4 Applicants disclose: ***"These techniques enable the planarization of micron scale colloidal crystal-based 3-D PCs that are demonstrated to function as ideal single crystal 1-, 2- and 3-D diffractive optical components."***

Further, on page 8, line 2: ***"Single crystal colloidal crystal diffractive optical structures of the kind described in this invention promise to be ..."***. For specific examples, the Examiner's attention is directed to page 35, lines 3 to 9 where it is disclosed that ***"The observed color of reflected light from the opal micro-channels originates from Bragg diffraction of photons by a face centered cubic arrangement of silica micro-spheres and air voids within the opal photonic lattice."*** and on page 37, lines 4-5 where it is clearly disclosed ***"The consistency of Bragg diffraction and side lobes observed for each of the opal micro-channels confirms the reproducibility of size"***

On page 9, lines 24 to 27 clearly disclose the attainment of a composite ***“material showing clear optical properties characteristic of a high quality photonic crystal...”***.

There are numerous other examples in the description which support these amendments to claim 1. Original claim 9 described the inverted structures as being photonic crystals which is because the original crystal is also a photonic crystal. The summary on page 53, lines 18 to 26 clearly shows all the methods have been demonstrated to produce photonic crystals (line 25).

The terms “closed indentations”, “closed channels” and “open and continuous channels” are all supported in several places, for example on page 23, lines 33 to 35, and page 24, lines 7-10. Thus, Applicants submit all these amendments to claim 1 are supported by the other claims as well as the description as filed and no new matter is added by these amendments.

Claim 2 has been amended to recite the photonic crystals formed in the surface relief patterns to be one of 2-D or 3-D colloidal crystals, support for this being found in several places, including page 45, lines 24 to page 46, line 22. Claim 5 has been amended to include the phrase “are one of silicon dioxide (SiO₂) and latex microspheres”. Support for this is found in several places in the description including for example on page 28, lines 25-26.

Claims 17 to 86 and 101 have been withdrawn in response to the Restriction Requirement, without prejudice to Applicants filing these claims in a divisional application at a later date.

Claim 91 has been amended to more clearly recite the product being produced in the product by process claim.

Claim 92 has been amended to essentially incorporate one of the limitations from claim 93, namely that the second particles have a different size

than the first particles. This results in regions of different sized particles as stated in the preamble.

Claims 99 and 100 have been rejected under 35 U.S.C. § 112, second paragraph as being indefinite. The Examiner has noted the use of the Trademark "Lincoln Log" has been used. Responsively these claims have been amended to remove this phrase and therefore Applicants respectfully request withdrawal of this rejection.

New claim 102 has been added which depends from claim 92 and limits the structure of alternating sized particles to alternating grooves with differently sized particles in adjacent grooves, see figure 23a of the present application for support.

Patentability of the Claims Over the Cited References

Claims 1-14 and 87-90 have been rejected under 35 U.S.C. § 102(b) as being anticipated by the reference United States Patent No. 6,436,187 B1 ('187) issued to Patel et al. Reconsideration of the grounds for rejection under 35 U.S.C. § 102(b) is respectfully solicited for the following reasons.

Patel et al. is directed to a method of producing a colloidal crystal template onto which colloidal crystals are grown. This is achieved by using a surface relief pattern which satisfies several conditions. Patel notes that the problem they are trying to solve relates to templates such as those provided by Blaaderen (column 2, lines 42-44 which have a "*cross-sectional structure having 90° angles between the hole walls 12 and the template surface 14.*" as shown in Figure 1 of Patel. This is also discussed in column 4, lines 27 to 38 of Patel. Due to electric field distortions near the corners this prevents the colloidal particles settling into the channels-also shown in Figure 1 of Patel. Patel discloses overcoming this problem by making a template as shown in Figure 2 of Patel. The Examiner's

attention is directed to column 3, lines 1 to 8 where Patel discusses their template is produced with rounded edges and alternative methods for producing their templates are discussed in column 6, lines 1 to 13.

The disclosure referred to by the Examiner in column 3, lines 9 to 36 simply defines Patel's definition of a colloidal template made by their method (lines 9-24) and gives Patel's guidelines for producing the template (lines 25-36). These guidelines are further expounded on in column 5, lines 6 to 46. Once the template has been produced typically having dimensions on the order of a sphere to be deposited therein (Figures 2 and 3 of Patel), a first layer of colloidal particles is deposited into the template, after which the 3D colloidal crystal is grown on top of the this first layer. Therefore, Patel describes a method to create three-dimensional colloidal crystals by using a surface relief pattern, which acts as a guide for the first layer of colloidal spheres deposited onto it. Once this first layer is deposited in a **square arrangement** (see Fig. 4 of Patel) and claim 1, line 48) subsequent deposition of new sphere layers would supposedly give rise to the three dimensional structure that is claimed in their patent.

In the first instance, while Patel et al. order a **single layer** of spheres **onto** a surface relief pattern, the present invention by contrast orders a **whole** colloidal crystal **within** the surface relief patterns. That is, the present invention as embodied in claim 1 allows one to build colloidal lattices **within** surface relief patterns that will host **the whole structure**. While Patel et al. invention only describes how to template the crystallization of a **single** square or hexagonally arranged sphere layer **onto** a large area surface presenting a surface relief pattern in which the depth of the relief is always of the order of a single sphere diameter or less.

Secondly, Patel discloses the need for the template structure to have a periodicity, see for example the first *principle* (column 5, line 10) of making the

template as disclosed in column 5, lines 14 to 23. Applicants surface features are not in any way restricted since the closed wells or indentations or open or closed channels are not required to be periodic across the surface, which is a reflection of the point made above that photonic crystals may be grown in each of the surface features. In addition, while Patel requires rounded edges of his template, (column 6, lines 5 to 10), Applicants surface relief pattern does not require this.

In addition, Patel is silent with respect to obtaining photonic crystals as have been achieved with Applicants products embodied by claim 1. Thus, on several points Patel teaches away from the present invention, and Applicants respectfully submit Patel does not disclose the subject matter of present claims 1-14 and 87-90.

Claims 1-6 and 87-90 have been rejected under 35 U.S.C. § 102(b) as being anticipated by the reference to Gates et al. in their publication:

“Self/assembly of meso and nanoparticles into 3D ordered arrays and its applications”, Proceedings of the Materials Research Society, Spring Meeting 1999, pages 149-154. Reconsideration of the grounds for rejection under 35 U.S.C. § 102(b) is respectfully solicited for the following reasons.

Gates teaches how to create three-dimensional arrays of colloidal particles whereby, as disclosed on page 149, lines 25 to 27: *“colloidal particles are self-assembled into cubic close packed (ccp) arrays under the confinement of a specially designed cell”*. This specially designed “packing cell” (line 2, page 150) of Gates is two glass plates which a square frame of photoresist sandwiched between them and held together by binder clips. Gates et al. teach in their paper that these two parallel glass plates are separated by this thin photoresist frame through which channels have been drilled to allow the liquid in which the colloid particles are suspended to flow out of the space confined between the two parallel plates. Therefore, these channels are just the

drainpipes for removing the solvent from the sphere suspension inserted between the plates and no crystallization takes place. In other words, the colloidal particles are confined within two glass parallel plates, but none of them possess a surface relief pattern as recited in claim 1 of the present application.

Further, as seen on page 151, lines 8 to 10 and figure 1B, the two glass substrates are removed to give a free standing structure formed of a cubic close packed array. Thus, to emphasize this point, the channels in Gates et al. have nothing to do with surface relief patterns as described and used in Applicants' claim 1, they are completely different and used for an entirely different purpose, just drainage for the solvent in which spheres are suspended not crystallization of spheres.

Finally, the present invention as recited in claim 1 provides colloidal photonic crystals formed in each of the surface features which exhibit Bragg diffraction. There is no teaching of this in Gates.

Claims 1-4, 15, 16 and 87-90 have been rejected under 35 U.S.C. § 102(b) as being anticipated by the reference to Clark et al. (U.S. Patent No. 4,728,591). Reconsideration of the grounds for rejection under 35 U.S.C. § 102(b) is respectfully solicited for the following reasons.

The Examiner has taken the position that based on Clark's disclosure in column 3, lines 24 – 31 and column 5, lines 33-54 that this reference teaches producing a surface relief pattern in the substrate surface and self-assembling colloidal particles in such pattern. The thrust of Clark's invention is to provide articles having nanometer scale features on a surface of the article. Referring to the Abstract, Clark states these are produced by *"employing a substrate base or coating and a thin layer serving as a lithographic mask or template, consisting of a self-assembled ordered material array, typically a periodic array of molecules ..."*. Later, in column 2, line 30 and 31 it is specified "Such nanostructures are

based on nanometer patterns created by self-assembled two-dimensional arrays”.

In contrast, the present invention as recited in claim 1 provides colloidal photonic crystals formed in each of the surface features which exhibit Bragg diffraction. Clark is completely silent with respect to this type of composite material and provides no disclosure whatsoever that would lead anyone skilled in the art to the subject matter of claim 1.

Claims 91-94 have been rejected under 35 U.S.C. § 102(b) as being anticipated by the reference to Asher et al. (U.S. patent No. 6,014,246). Reconsideration of the grounds for rejection under 35 U.S.C. § 102(b) is respectfully solicited for the following reasons.

Claims 91 and 92 have been amended to more clearly define the product produced by the methods recited in each of these claims. Applicants' review of Asher shows the latter teaches a colloidal array maintained in an aqueous medium, see column 4, lines 48-54, note lines 50 to 52 in particular, and independent claims 1 and 11, 18, 28 (hydrogel). In one embodiment shown in Figure 2 of Asher the array is maintained in a chamber 16 containing water 14 and particles 12 forming a dispersion in the water, see column 6, lines 66 to column 7, line 5 where the ratio of water to particles is disclosed as being a variable so as to effect the diffraction wavelength. In another embodiment of the array Asher discloses using a hydrogel to contain the colloidal particles as disclosed in column 8, lines 12 to 44 of Asher.

Claim 92 of the present application recites a lattice parameter modulated colloidal crystal film based on regions containing differently sized particles built on top of a planar substrate and has been rejected by the Examiner on the basis of the previous disclosure of a similar product by Asher et al. in the aforementioned patent. In the sections of Asher's patent referred to by the

examiner (col. 9, lines 1-62; col. 5, lines 41-56), what is pointed out is the fact that their materials can be made of spheres of different diameter which would lead to different diffraction peaks. However, Asher does not teach two different sized particle types would coexist in the same film forming alternating particle size colloidal crystals and leading to a periodic variation of the optical properties, as it happens in the structure of claim 92. In fact, the production methods disclosed by Asher do not allow such a product to be obtained. Mixture of spheres of a different type, composition or size, in Asher's preparation substance can only lead to a different crystalline structure of the whole lattice or disorder, but not to periodically alternated colloidal crystal microchannels having particles of different sizes contained in each.

Thus, Applicants respectfully submit the subject matter of claims 91 and 92 are not disclosed in Asher, and certainly the products formed by Asher are not formed according to the method of formation recited in claims 91 and 92. In view of this Applicants submit claims 91 to 94 are patentably distinguishable over Asher.

The examiner has rejected claims 96-97 under 35 U.S.C. § 102(b) as being anticipated by on the basis of being anticipated by Maenosomo et al. (U.S. Patent No. 6,337,117). In the Maenosomo patent, their colloidal particles are luminescent nanoparticles, which luminesce, that is, they present luminescence (col. 11, lines 3-11; col. 12, lines 43-61). Further, "the particle size distribution of nanoparticles is arbitrary" (col. 14, lines 4 and 5), since the optical effects they make use of are not based on diffraction, as in the present application, which would require a narrow particle size distribution and the precise ordering of the particles in a particular lattice. This is why in claim 96 there is recited a "first array of first colloidal particles of a **first size**... and a second array of second colloidal particles of a **second size**", which in the case of spherical particles these will be

monodisperse. Further, their product is based on particles whose size ranges between 0.05 nm and 100 nm (col. 11, line 5). Particle sizes must be limited to this range for their invention to work, as they point out explicitly (col. 11, lines 6-8), a limitation not applicable to the present invention. Furthermore, their product displays different colors in different regions of the film as a result of the different luminescence of the particles in each region of the film (col. 14, lines 23-30), which results from the different particle size or composition in each one of these regions. In our case, in contradistinction the different colors displayed by the different parts of the film result from the different diffraction taking place in the different sphere size colloidal crystals that form it. In their case, electronic excitation of the particles is needed in order to cause the emission of light from them and observe different colors. In the present invention, as recited in the claims, what is observed is Bragg diffraction so that simple illumination under white light is enough to see different colors.

In view of the foregoing, reconsideration and withdrawal of the rejection of claims 14-33 is respectfully solicited and favorable consideration and allowance of claims 14-33 and 66 is requested.

Should the Examiner have any questions regarding the allowability of the claims with respect to the art, it would be appreciated if the Examiner would contact the undersigned attorney-of-record at the telephone number shown below for further expediting the prosecution of the application.

Respectfully submitted,


Dowell & Dowell, P.C.

By:

Ralph A. Dowell, Registration No. 26,868

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DOWELL & DOWELL, P.C.
Suite 309, 1215 Jefferson Davis Highway
Arlington, VA 22202
Telephone - (703) 415-2555
Facsimile - (703) 415-2559
E-mail - dowell@dowellpc.com